

**Semiological aspects of urban maps:  
A case study from the Holy city of Mecca**

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**Key words: Graphics semiology-urban planning-Meccah-Master plans**

**Abstract**

During the last decades, the cartographic discipline has accomplished, an electronic "transition" (Monmonier, 1989). Tremendous advances were made in the Cartographic design as well as in the Cartographic production. However, the overall positive development provoked by map automation has taken different forms and has not come without serious pitfalls with regards to the semiological aspects of the resulting maps or graphic documents. For instance, map automation has had very little effect on the multivariate maps, the preferred tools of the planners or urban developers. These professionals working on space still need to put side by side more data on the same space, to link these data and generate a summary or to make a decision depending on all these data.

In planning studies, in particular, automation has not solved the problem of traditional sketches, or master plans, even if the Geographic Information Systems (GIS) have provided powerful tools to storing, handling, analyzing and visualizing data and therefore giving interesting solutions. In this research, and through some planning students' works in Jeddah, we intend to give some cartographic comments and reflections when handling several layers of data. In particular, visualization and map reading are profoundly discussed with regards to Robinson design principles towards colors typestyles and other graphical signs (Robinson, A. H., 1952) and Bertin's theory on signs perception and on semiological aspects of maps (Bertin, J., 1999).

**Introduction**

The cartographic design is a long process that involves, at one moment, a decision making depending on the signs and colors of the resulting map. Unlike the perception of verbal or written messages which allow their refining and the development of implicit or hidden aspects, this decision is **complete and total**. The perception of the cartographic document is a **complete reaction** to one image. Therefore, communicating by using maps must be a well-studied process from the **semiological point of view**.

It has been proven that maps belong to **the world of images**, and therefore can be considered as an extremely **powerful means of spatial communication**. From the angles of message perception and impact on the reader, the cartographic documents are even more powerful than texts, discourses or numerals, as demonstrated by former geographers and cartographers such as Balchin (Balchin, G. C., 1972), Robinson (Robinson, A. H., 1967) and Bertin (Bertin, J., 1983 and 1992).

But maps may also mislead the lecturers, when not respecting the semiological grammar rules they should take into account. If we accept the fact that there is more than one single method for presenting the same spatial information, all of the proposed methods must convey the accurate and precise message of the map maker with respect to content. This does not always happen, especially

when map makers are more likely focusing on thematic aspects than on design and graphical aspects whereas both aspects are actually strictly linked. In the planning field, the planning concepts often appear more important than the ways to convey them, especially for beginners in planning. In this paper, we will examine some samples of students' products from the semiological point of view. We will check if the maps on the posters do answer the real questions a planner should address to rapidly understand one specific issue by reading maps. This is mostly the case of multivariate maps which address several aspects at one moment, but it is also the case of univariate maps.

### **Objectives of the study**

The overall goal of this paper is to underline the necessity of a semiological analysis in map production, regardless of context. A solid background and training in the subject has to be realized first to reach this goal.

Through the examination of the samples produced by planning students, several objectives of the map analysis process are defined. We aim to:

- Examine the whole process of creating maps through the students' map production;
- Identify the cartographic errors starting from the semiological rules;
- Demonstrate the lack of care about the graphical semiology at the output of this process which may generate some errors in readability and perception;
- Propose some insights to avoid these pitfalls;
- Provide some concluding remarks and recommendations to avoid errors and enhance cartographic communication with regards to the theory of graphics semiology.

### **Materials and Data**

The central zone of the Holy city of Mecca has viewed substantial construction developments of Haram al-Sharif in the last decades. But more likely these developments still do not satisfy the future expansion of the city and this is due to the increasing number of pilgrims. The concept was to design four pedestrian paths from the Holy Mosque to the Third Ring Road. Students have to produce posters covering all themes on the existing data as well as the design of the concepts they propose.

In order to decongest the central area, the students' proposals intend to:

- Facilitate the movement of pedestrians and vehicles between the Third Ring Road and the Holy Mosque;
- Maximize the usefulness of the new expansion to the new pilgrims to get to and from Al Haram easily.
- Upgrade the existing slums located along the axes of the new paths, not far from Al Haram.

The case study is constituted by a set of posters on the Holy City of Mecca created by planning students and presently chosen for cartographic evaluation purposes. In this work, we aim to demonstrate that most of the planning students in particular, more or less unconsciously, do not pay sufficient attention to the **semiological aspects of the map**. The results may differ from one case to another, but sometimes, the produced maps may be inconsistent or poorly-designed and include various and heavy "**noises**". We will focus on these "**noises**" in order to demonstrate the possible enhancements in terms of overall readability.

In general, these posters are composed by many types of documents: maps diagrams, photographs, sections?, texts, tables and 3D views. In this paper, we will exclusively address our remarks to the graphic and cartographic aspects. The scientific purpose of this paper is to assess the student's graphical and cartographic skills, whether using GIS or not.

### **The semiological background and the proposed methodology** **Brief insights on thematic cartography**

When addressing semiological aspects in cartography, we return inevitably to the fundamental question prior to any design using the visual language of the rules applicable to the graphic image. Any cartographic product has to answer at least one of the two following questions:

1. What happens at one given place?
2. What is the spatial distribution of one given geographic variable?

The answer to the first question implies the recognition of all objects and phenomena in a specific location of the study area. This is the main goal of topographic mapping: to locate and identify objects and phenomena in space by the selection of signs, figures and colors on the map. Thus, focusing on details, precision and accuracy does not allow an overall reading or even an intermediate level of reading (Bertin; J. 1977, 1984 and 1999).

Concerning the second question, mapping allows answering either prior simplification of the initial data, by one or by using some methods of information processing, or even by processing maps that reflect the correlations, classifications and typologies. Hence, the main scope is to give an overall overview rather than a detailed one.

If one is concerned with the two reading levels, simultaneous elementary and global responses in mapping become more difficult and hard to assure in one single document. That is the problem of mapping overlay: first to create a cartographic map assuring completeness and accuracy that is, topographic data; second, to assure readability and clarity of the document in order to comprehend immediately the essential message conveyed, although some solutions have already been proposed (Bonin, S., 1983).

Thus, these two questions address the two major subdivisions in cartography: topographic cartography versus thematic cartography. But we wonder if this subdivision is still very useful today especially in a GIS context. Most likely, this dichotomist view of the field of cartography is changing to a less strict kind of new maps, especially produced in a GIS context, that refer to the two areas of interests. The point is that in many cases we do need accurate location of features as well as the thematic attributes of these features. The logic of conventional signs used in topographic cartography does always prove to be helpful in thematic cartography where the main goal of the cartographer is to transmit correctly one message, that is, to choose the valuable visual variables depending on the theme properties.

### **The use of visual variables according to their properties**

In general, the cartographic design may transcribe one, two or more attributes or spatial variables. According to the present case (students posters on the Mecca Holy Site Paths Project), the cartographic solutions to single attributes are supposed to be relatively well known and widespread with regards to the written literature and the theoretical fundamentals of cartography and especially the visual variables. These attributes require the use of one of the six retinal variables (size, value, grain, color, orientation, shape), or even a combination of two or more of them when corresponding to the main attribute properties such as size + value, value + grain, color + value, size + shape, etc .... (Bertin J. 1999).

In the case of two geographic attributes, we could just use two visual variables, each one corresponding to one single attribute and conveying its property of similarity, difference or proportionality. But we could just use more than one visual variable if the second variable enhances the main property of the first. For instance, variation of color may enhance the layout of value and orientation may enhance the transcription of shape. In anyway, one cannot use a visual variable only for its esthetic value without taking care of its level of perception. Using color to show quantitative attributes is an undeniable error (Bonin, S., 1983).

As demonstrated in the cartographic literature, the methodology we apply when assessing the students work is inspired from Bertin's major work on the Semiology of Graphics (Bertin, J. 1999). We insist on the respect of the rules included in the following table inspired from the major work of Bertin but slightly modified and adjusted by the author. What visual variables should be used

depending on the levels of organization of the components of information and the type of geographical objects? How to "inform" correctly the overall relationship of difference, order or quantity of these variables simultaneously, while respect as closely as possible to the "weight" and the impact of each one? This table proposes some responses through a new slightly modified understanding of the main properties of the visual variables (Dhie, M. 1986, 1995).

**Table 1: Visual variables properties (based on Bertin, J. 1999; slightly modified by the author)**

	Associativity	Selectivity	Order	Proportionality
<b>Size</b>		XXX	XXX	XXX
<b>Value</b>		XX	XX	X
<b>Grain</b>	XX	XX	X	
<b>Color</b>	XX	XXXX	X	
<b>Orientation</b>	XX	XX		
<b>Shape</b>	XXX	XXX		

X : weak property; XX: medium property; XXX: strong property; XXXX: very strong property

### **The issue of multivariate representation of data**

The application of these rules to the present case reveals that these properties were globally respected by students when representing one single attribute. The problem becomes more complex when it comes to process and represent on the same document several layers with various types and different locations (point, linear, zonal, or even volumetric data) on the one hand (Bonin, 1982, Dhieb, 1987). On the other hand, we can ask: how to find a graphical semiological solution equivalent that match the high number of initial data and maintain at the same time readability, clarity and accuracy of graphic document? How to be sure of the good assimilation by the reader when perceiving various signs? How to ensure document effectiveness and relevance that can be measured in terms of the time spent in assimilation? These are a few questions that should be asked before beginning any cartographic work in planning.

### **Discussion about the work**

#### **General remarks**

First, we should advise the readers that we will not examine the text mistakes or lacks or the weakness related to photos produced on the posters. We will focus only on the graphic and cartographic design production through some of the posters.

It is obvious that all maps or diagrams are composed of content and container, but in thematic mapping, the accent should be placed specifically? Exclusively? on the first item. The suitable way to perceive the map content is to present it in a legible, understandable and valuable manner. Therefore, semiology of graphics and maps is crucial to communicate the messages in a valuable and valid way. Several remarks may be given. We cite only the following:

1. At the first look to the big number posters, we observe that most of them do not obey this fundamental rule. Various posters containing pieces of texts, titles and subtitles, insets, photographs, frames, scales, north arrows, colors, lines numbers and legends, that is secondary elements of the map, have a too big visual effect or impact in terms of perception.

2. Many posters are composed in fact by a collection of various figures, texts, icons, photos, diagrams. If we admit that this heterogeneity is a requirement in a planning context, we assert that little focus was placed on maps and diagrams.
3. Most of the posters use multiple dark colors that affect the overall perception.
4. Many design errors behold the inconsistency, the incompleteness of the maps and diagrams.

These remarks to some posters are not the unique reproaches we should address; they seem to be the principal. We will not examine rigorously the numerous detail errors and misleads having in mind the student character of the production but we will give only some specific remarks.

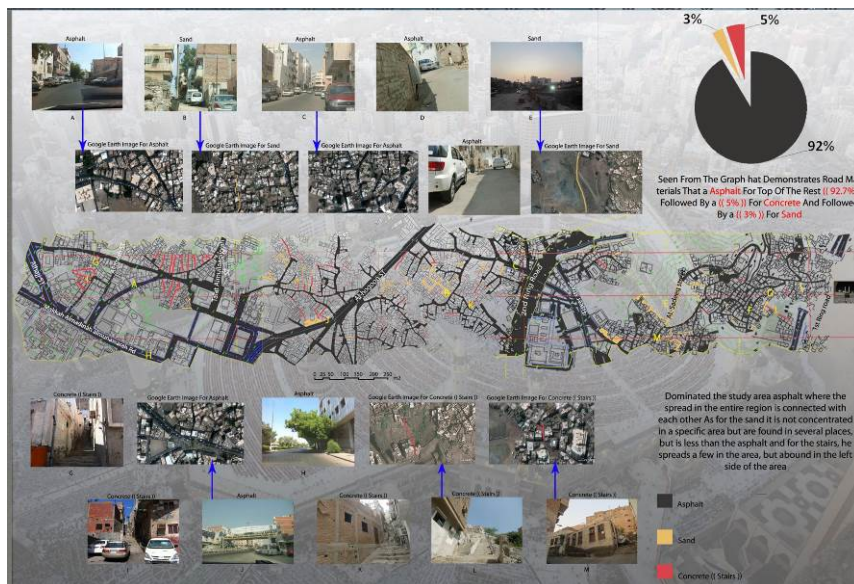
## Specific remarks

### The weakness of overall visual impact

This poster aims to show the Ring and Highway Roads around the Holy Mosque. We remark the little place provided to the map on the whole poster whereas photos and other comments occupy a most much bigger place than the map which seems very "light" by comparison.

The use of yellow lines for one type of road - even if it respects some conventions - does not help in distinguishing the various types of roads.

Generally speaking, the overall tone of gray is dominating the poster which does not help the readability of the data.



### The misuse of color

On this poster dedicated to Mecca districts, we may note that it is composed mainly of a central map, an inset map, a table and a diagram. The place accorded to the map seems important. The use of colors seems correct from the outset logical in some way because wherever placed (in the central map, in the inset, in the table or in the chart), and depending on their area, the districts have the same color (Robinson, A. H., 1967).

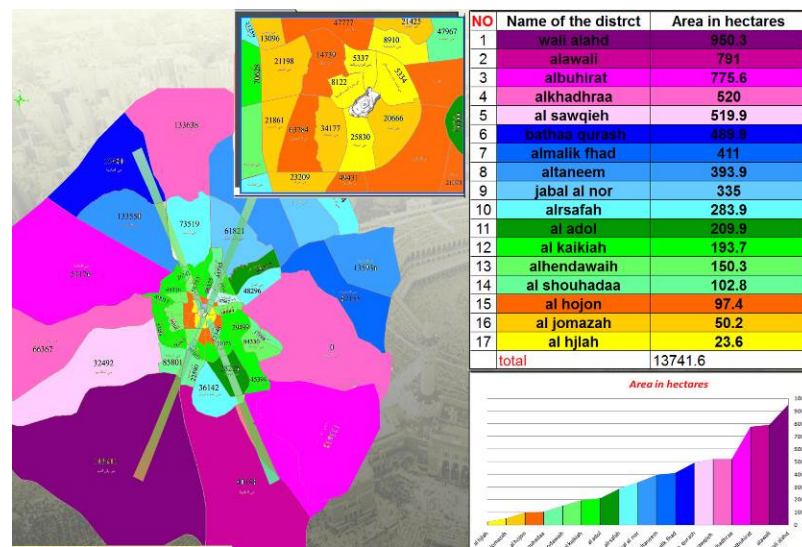
The point is that it is well-known that colors hue does not convey order but differences. According to the color properties (*associativity*, selectivity) color does not represent absolute numbers, which is the case here. Moreover the four sets of graded colors used, because of the big number of the districts (17) is not clearly justified.

Perceptually, the weight of the light purple is less imposing than the dark green or the dark orange. The numbers on the districts showing their area do not help in distinguishing and mainly in comparing areas even if colors are very clearly represented.

Data processing was not clearly stated (How categories were put in classes?)



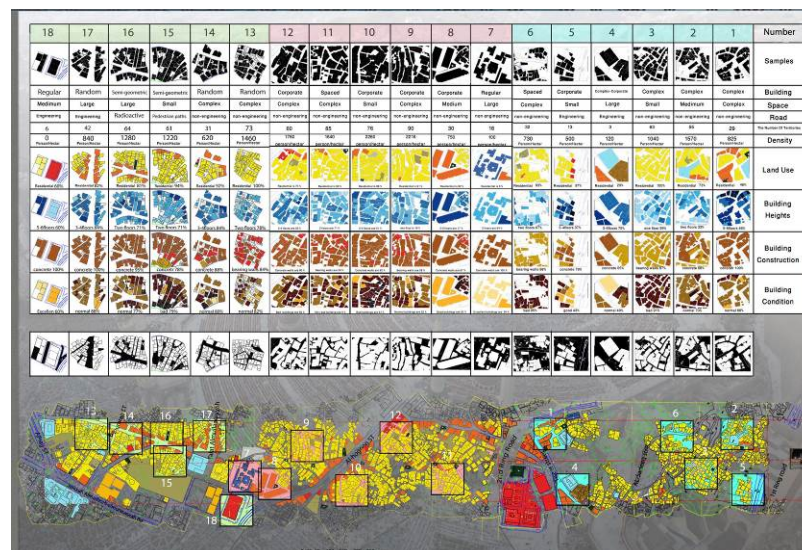
One solution is just to place the districts on the map without any number or symbol as their real area is shown by the map. The table is not useful as the diagram may represent correctly the differences between areas.



### Difficulty of overall readability

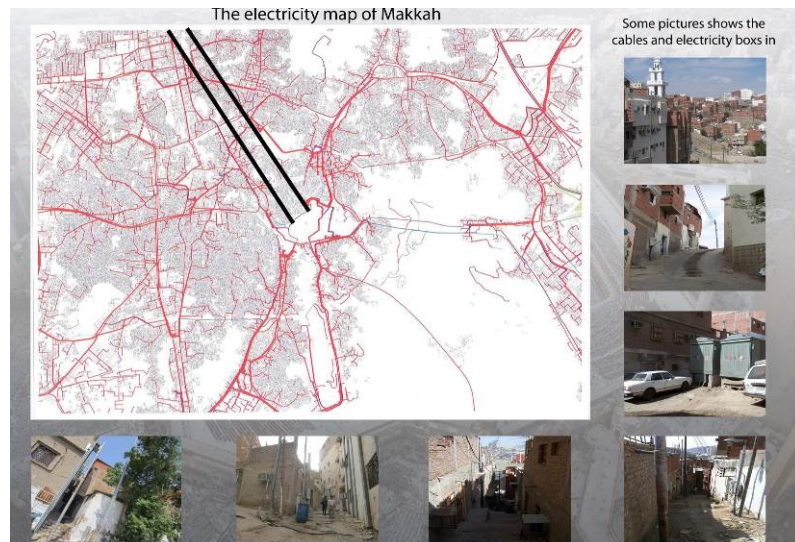
Obviously, this poster presents rich data that cannot be understood totally from a first glance. The sets of small pieces of maps, texts, numbers organized in a table and covering various portions of the space and various themes such as building conditions, building constructions, building heights, land use but also other attributes such as density on the urban fabric assure a detail level of reading but not the total one.

Probably, a synthetic map showing the main urban fabric categories is much more useful than these pieces resembling to a certain degree a puzzle.



### The keys problem

The main reproaches one should address to the above posters are the lack of legends, labels, sources, methods used...



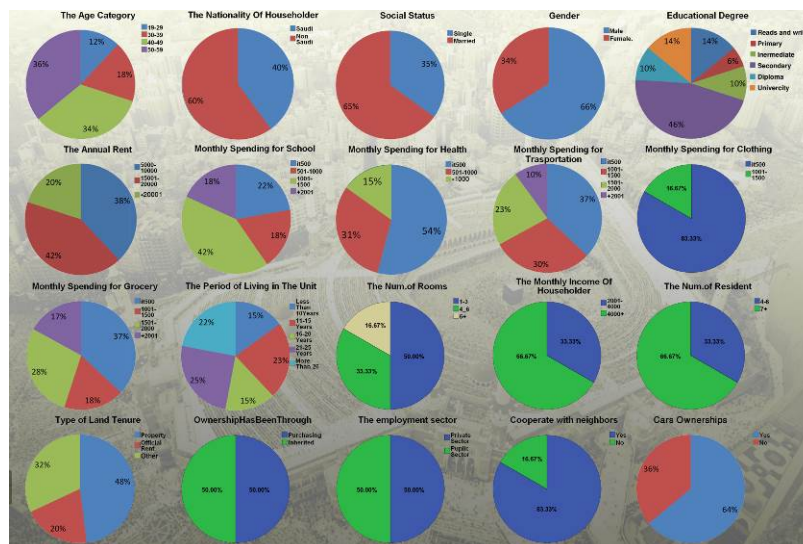
### The hints of the diagrams

The main observation concerns the repetitiveness or even monotony of diagrams: there is no variation in types, shapes, size... Even the colors used and generated by the software remained unchanged by students and still belonged to the same set of greens, blues, reds...

The main reproach addressed to the pie-charts diagrams, when used in a great number is inherent to the difficulties of reading. As revealed by Bertin, the circular lecture is much more difficult than the rectilinear lecture (Bertin, J. 1999).

When examining the data, we may imagine using other types of figures such as pyramids for age structure.

No relations between the diagrams \no synthetic view of the attributes



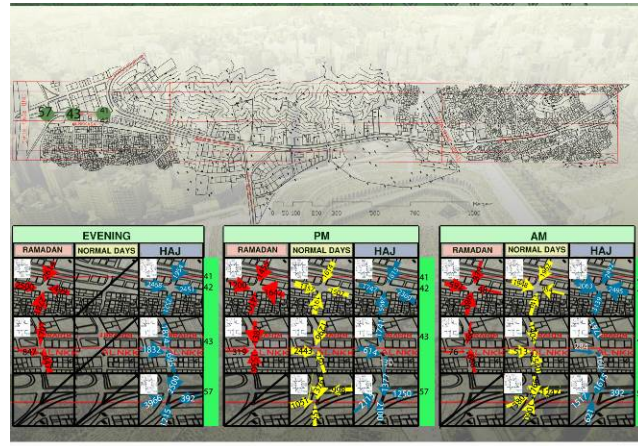
### The design of arrows

The design of arrows showing the traffic of vehicles during selected periods of the year intends to give an idea about the traffic density especially during the Haj period and at selected journey moments. This design includes some inconveniences:

- The arrows do not convey the precise direction of the vehicles;
- The choice of different colors which is not required. Moreover, it may mislead when talking about the same items;



- The heads of the arrows are too big;
- The traffic numbers on the arrow do not help in reading;
- The direction of the arrows does not correspond to the reality;
- The very end of the arrow does not stop at the same level.



### Main information and secondary information

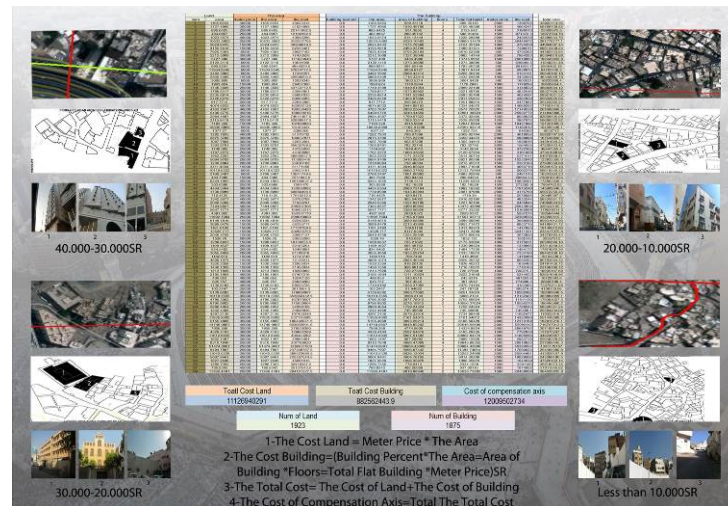
The main information is hardly seen: the whole axis on the poster occupies exactly one of five from the whole poster area. Moreover, the main information does not occupy more than one to tenth from the axis, which means that the axis occupies less than one to one hundred of the total area of the poster. If we add that the black on the gray foreground is easily selected and that other items such as photos and a background constitute other information on the map, we may assume that the total retaining message is very poor.



### The use of tables

Some posters were drawn exclusively by using tables. If the context requires sometimes having an idea about numbers, yet readable, such as the total cost of the project or the amount of compensations, diagrams or specialized information may give a much better idea about the spatial distribution or the contrasts observed.





### Comments about the results

At the very beginning of this work, we had in mind some hypothesis about the misuse of semiological rules. We checked how they were applied by planning students. After having examined the few posters let us remember some:

1. First, we have to admit that signs of the map are not "transparent", that is, not totally objective (Robinson, A. H., 1996). Perception of the message on the map is a very complex process allowing all non-divisible dialogues through a cognitive process. During the reading process mapping, the reader does not have freedom of interpretation since the signs are used to represent specific features (Muehrcke, P. C., 1986).
2. A map is not necessarily a simple tool for illustration and information representation. It has a processing function and a research function too, even in operational fields such as planning. The produced map or diagram corresponds to a moment of a reflection and the ideal map is still searchable and modifiable...
3. A map can be used to find and locate objects. This is its primary function, but historically as a world model and representation of the reality around us, the map becomes a tool that allows us to better understand not only the existing objects, but the nature of relationships between them. This is achieved by the process of scale. We must not forget that the scale of the map, and consequently its size, is determined by the degree of readability. Map makers have to keep in mind this rule to dress maps at a scale allowing the understanding of the data and their spatial distribution
4. The produced maps or charts are based on the use of symbols whether conventional or created by their authors. The success of the map depends largely on the recognition of symbols used to represent phenomena. They must be chosen according to their perceptual properties, be clearly labeled in legends and impact the lectors positively.
5. Spatial information in its textual form is a written language and then is *polysemic* whereas the graphic or cartographic document is *monosemic*, that is, each of them obeys a different logic of perception (Bertin, 1967). Confusion or lack of perception of these two distinct models of communication is often a source of ambiguities and errors in the preparation of a paper chart and we assume it was the case in the present case. We "read" texts but we "see" maps and diagrams (Bonin, 1983). We are not sure the distinction between these two different ways of understanding reality was assured by planning students.
6. The map or diagram uses a visual language. The map is essentially an image that has its own perceptual logic. Number of perceptual rules is implied by this view. Legend intervenes only to give orders of magnitude or the nature and meaning of phenomena represented. As it uses a visual language, the fundamental question that arises frequently is the identification and definition of a coherent and consistent relationship between the data or information and

graphic tools used to treat, view and communicate to the reader or graphically map. Obviously, through the students' production, this idea of strong relationship between the concept and its design was not clearly stated.

7. But a map may provide a synoptic view of reality through the process of generalization. Therefore it may contain a considerable number of objects and relations included in a single graphic image, relationships are directly deducted if not transcribed directly from the map.
8. The map simplifies reality and as in all operations of simplification, there are hazards, risks, both at the level of simplification (is that enough? Is it too much? Where is the optimal degree of simplification?), and the level of quality and rationality of the process of simplification and generalization adopted, regardless of the degree of simplification and generalization chosen. For example, in a choropleth map, there is a partition into classes and categories are represented by different colors gray tones or patterns (Jenks and al., 1977; Cauvin et al. 1987; Belhédi; A. 1990). But whatever the method adopted partition, any choice is questionable from the start. Ambiguities may occur, due to poor choice of threshold value classes or the number of classes in terms of reading the card. Such aspects should be discussed and the choice of one method clearly explained on the map.
9. Like all other means of communication, the map is for a reading public more or less extended, more or less diverse. Targeting the message according to a profile of the average reader is not an easy process, graphically speaking. Despite all the research and investigations in approach motivations, reactions and responsiveness, a significant proportion of these mechanisms remain uncontrolled.

## Conclusion

This paper presented first a practical example of some difficulties inherent to single or overlay mapping in planning. The map maker is often called to process and visualize layers of information needed to make (or help to make) any spatial decision. He has to choose the **adequate visual variables** according to their properties of **associativity, selectivity, order and quantitativity**. He has also to forecast on the **real impact produced** on readers.

Second, we have shown through few samples, that, the map user should be **aware of all the data** relating to the research project, aware of their natures, their locations, their spatial extension and especially their degree of reliability. This aspect is not specific to the discipline since mapping is found in all the other social sciences and space, but it is a crucial and critical issue in mapping.

How to realize the **degree of conformity between reality and the signs** on the map? In other words, how could we reduce the gap between reality and its representation especially in planning? The use of symbols and colors obeys rules belonging to other scientific fields dealing with images, the way to process data, and the way to express in order to convey the good message to the readers. The quality of one map is directly dependent on the author and the cartographer comprehension of these rules and the quality of the information transmitted depends on aspects of accuracy and lector assimilation.

This paper aimed at demonstrating that the **lack of semiological fundamentals may mislead possible readers** and therefore give a poor result especially when using GIS. The semiology of graphics must be taught to planning students as they have to produce a big number of maps, charts and various diagrams (Bertin, J., 1984 and 1999; Beguin et Pumain, 1994).

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\*I would like to thank Prs Abdelkader A. Murad; Abdullah Abdel Nasser; Wahid Salem, my colleagues and all the students from the third level URP394 - the academic year 1432-1433 for their grateful contribution to this work. Some of their works were used anonymously in this paper.